Packet Radio In Montreal

Since the Montreal group was the first into packet it is not unusual that this group is the furthest advanced in this technology. A system has been fully operational since August of 1979, and has been continually updated since then. There are currently six stations on the net, with more working on modems and computers right now.

The net operates on 223.5 MHZ currently, but a move to 222.3 is expected as soon as all of the stations have their crystals. Audio frequency shift keying is used, at 2400 bits per second. The mark tone is 2400 HZ and space is 4400 HZ. The modem is based on the Exar 2206, 2211 chip set, with a credit to Ted Balesta VE3CAF who first suggested the design. Having experimented with the design for almost a year now, it is capable of error free transmission with S/N ratios of 15 DB or so. Its pefection is due to the efforts of Jacques Orsali VE2EHP who "massaged" the design to its present performance levels.

The radio is typically the Midland 13-509, running ten watts. It was chosen on the virtue of simplicity and price. The modifications to it required are simple and can be done in about thirty minutes or so. The interface to the radio was deliberately kept as simple as possible in anticipation of future users who may be either unwilling or unable to make extensive mods to the radio. Since just recently, Ted VE3CAF has joined the Montreal team, we expect that he will make substantial improvements to the interface.

The local net is being used for man to man communications mostly, but lately the emphasis has switched to machine to machine transfers of programs, text files and the like. One user is currently writing a multi user real time war game which will be implemented on the net soon. One of the unresolved questions is what principal use the net will be put too once fully implemented. Since this will depend on the character of the users, it will stay a question for some time yet.

The network includes a store and forward repeater as part of the system, and this repeater is currently functioning. It was demonstrated at the RSO convention in the fall of 1979. It receives packets which have are flagged as packets for repeating, and rebroadcasts them a few miliseconds later. It serves the same purpose as a conventional 2 meter job, i.e. it extends the range of a station using it. Since there are no cavities(it is a simplex device) it does not suffer from the usual problems of desense, and split antennas. Naturally it is very efficient and as we say in the business, "it talks far".

The repeater operates on the same frequency as the rest of the net and only repeats pacs which are flagged to it. In this way

we find two stations often using the repeater while two others who are close enough use simplex , all on the same frequency. In addition to its conventional roll, Digptr as it is called, offers other services to the users. By sending a pac to it(as opposed to through it) users can get a "Broadcast Message" which provides important information of immediate interest. System shut downs, protocol changes and the like. The message can be changed remotely by the system operators, and is password protected. Users can also use the Digptr to check out their system. Using the Test facility a packet sent to Digptr will be transmitted back to the station the same way it was received that is, with or without errors. By accessing the status file of the repeater, users can see the number of pacs, and acks which have gone through Digptr, as well as those which were "direct" and bypassed it. System operators can use this function for statistics on usage, and throughput.

The latest and perhaps most exciting development is that we now have a single board computer/terminal working. It is based on the Motorola Chroma II kit, sometimes called the TV BUG. This low cost ($300 or so) device will implement the full packet protocol in PROM, and requires only a keyboard, a TV set and a compatible modem to run. This means that the cost of a complete packet setup is reduced by a factor of about ten. We figure about $500 including the radio would be the maximum cost for someone who had nothing to start with. For those people who have micro computers already, TV bug will be able to act as a front end processor, which will handle all the communications chores for a host machine. Once this is running, we can see some very powerful and exciting possibilities for distributed processing! Watch the newsletter for more information on this exciting breakthrough.

The protocol currently used is a simple "Aloha" type random access system. It has been enhanced however and uses carrier sense and priority acknowledgements. Since the current protocol will probably be defunct by the time this is published, here is the new version outline:

The Format

SYN		
SYN		
SOH		
Destin.	Call	6 bytes
Destin	Node	2 "
Origin	Call	6
Origin	Node	2
Service	Flag	1 (bit mapped)
Number	Flag	1 (bit mapped)
Lenght	Byte	1 (bit mapped)
Data		0 to 256 max
Checksum		2 bytes

The Protocol can almost be derived by looking at the format of a packet. It is carrier sensed, that is stations don't transmit if they hear another station on the air. Priority acknowledged. i.e. if a station hears a packet and the checksum is correct it is presumed that the destination station also got it correctly and that an acknowledgement will be forthcoming. The transmission of a waiting packet is delayed to allow the ack to go by unhindered.

Where a station fails to get a ack to a transmitted pac, it will try again, up to three times. The interval between retries is random to avoid two stations continually clobbering each others pacs. All pacs are preceeded by an ASCII SYN(synch) byte and the ASCII Start of Header characters. The Service flag is used to indicate by setting a bit high(1) whether the packet is an ack, a repeated pac or ack, whether this is a file transfer, an ASCII or binary data field, with a couple of bits to spare. The bits are arranged as follows in this flag:

```
Bit  7 6 5 4 3 2 1 0
     A R F B ? ? ? ?
```

Where A = Ack
R = Pac or Ack from the repeater
F = File transfer in progress
B = Data cantains binary coded info
? = Spare for future use

Note there was a terrific temptation to rearrange the flags to read as B A R F, but in software the ARFB series was easier.

The repeat flag is used to prevent a station from receiving two packets if he hears both the origin station and the destination. The computer will respond to and keep the R flagged one,and ignore the other. Don't forget the repeater transmitted pac will get there after the original since it is store and forward. The file flag is used to indicate that the receiving station should file the packets sequentially and not allow other packets to intrude in the file. You can imagine what getting a "Hi Bob " pac would do if it was inserted in the middle of a program I was receiving. Files are also written to disk on the receiving computer. The binary flag is used when a file (program etc) is binary coded as this would allow us to apply offset loading etc, to the file. It will also allow a program to "come up running" on a users machine.

The next flag the sequence count is used to keep packets composing a file in the right order. It will also be used eventually to implement a virtual circuit where a certain number of pacs will be allowed outstanding without acks. This will allow for improved throughput with an ACK to NUMBER (x) arrangement. The length byte is obvious it simply tells the computer how long the packet is. The only restriction is that packets cannot have more than 256 bytes in that data field. The last two bytes are the checksum which is used to establish that

the packet has been received error free. This is currently done in software but we expect to do it in hardware with the Fairchild 9401 CRC generator checker chip in the final version.

Obviously a full description of the protocol is beyond the scope of this newsletter, but the above will serve as a resonable outline of how things are done. Those who are interested in the inner workings can contact me by 'phone. Many elements are as yet optional, being on the user side of the interface, routing pacs to a printer or disk etc, is currently supported allowing a user to watch the evenings activities at his lesiure. Same with the Copy All Pacs, Copy My Pacs option.

The near future. Well we expect a fairly large influx of new users due to the imminent availability of the TV BUG design and our software on PROM. Since it serves not only as a computer but a video terminal as well it eliminates two of the most expensive elements of a packet system, for about $300 all up. We are building a new digital repeater using a singleboard Z 80 based device which is standalone, and by the month of May we should have it on the air in a location which will allow us access to Ottawa. Ted VE3CAF has acquired a TV BUG and our first tests will be with him.

We also expect that Ted will be able to help us out with a new modem design which operates at 9600 bps although at the expense of S/N ratios. It looks as if we can find another repeater computer as well which could be installed in Ottawa if the demand warrants it. We could then have our repeaters talking to each other as well which explains the repeater address in the header in case you haven't figured it out! That sums it up from this end and I would like to thank Hugh Pett for undertaking the coordination of this packet newsletter. I am looking forward to seeing the "state of the art" within other groups in Ottawa, and Vancouver to name just two.

The people in Montreal responsible for the development of the system in use are:
VE2BQF Fred Basserman Packet software
VE2BOS Norm Pearl TV Bug development
VE2EHP Jacques Orsali Modem
VE2PY Bob Rouleau Protocol DIGPTR
VE2BFH Bram Frank DIGPTR Statistics Software

73 de VE2PY
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Packet Radio Montreal

Montreal May 18th 1980. Since the last issue of the news letter there have been few if any earthshattering breakthroughs in this area. Some minor changes have been made to our header which was described in Number 1,consisting mostly of making the nodal address only one character long. It seems that 255 possibilities should be adequate for quite some time to come.

In answer to some of the questions about error checking, we are not currently using a Cyclic Redundancy Check, but rather a form of vertical parity. Each byte of the packet is Exclusive ORed with every other byte thereby generating an eight bit checksum which is contained in the lower order eight bits of the checksum word. The reason for this lies in our use of the MC6800 CPU which makes it difficult and slow to do a real CRC in software. This limitation will be overcome by using a hardware chip designed for the purpose. One such is the Fairchild 9401 CRC generator/checker which is being studied now. For the moment, the XOR and the inherent stability of our 2400 baud AFSK system works very well indeed. Users habitually transmit 30K byte source files which assemble without errors.

With this one exception our system is fully implemented and on any given evening, you can hear(see) transfers of files as well as man to man communications on the packet channel. The last version of the terminal program was distributed via packet to all users as a source file,and this 29K byte file took only about 4 minutes to send under the full packet protocol.

The latest version which runs on both 6800 and 6809 machines has one added feature over the last one, an automatic answerback. A user can format a packet which will be sent to any station that addresses a packet to his station. This is used to tell users when a station will be attended, how to address a printer instead of the CRT, or simply as a bulletin board. Neat.

Packet is now running on the Motorola Chroma II kit, better known as the TV BUG, and debates were heard as to what color the acks should be. TV BUG is a cheap single board computer which is also a terminal. The test jig consists of the BUG, connected to a small color TV set at the antenna jack,a surplus Vucom keyboard and the "Montreal Modem" connected to a Midland 13-509 rig. Naturally this system does not do any of the fancy file manipulation that the full blown systems are capable of, but it does do packet very nicely. Best of all, it's cheap. In the minimum configuration it cost about $400 less the radio. Naturally it can be expanded even to a disk system if desired, but as is it's a nice portable system, or, cheap starter setup. Both VE2BQS and VE2PY will be using these from their summer cottages on weekends. Software in PROM will soon be available for these kits.

The store and forward repeater is now complete, and tested. It has software in PROM, and implements the full protocol complete with error checking. It has undergone a 30 day burn in and runs very nicely. The heart of the repeater is a Z-80 with software by VE2PY. Preliminary discussions are underway for a site which will put a signal into Ottawa. The repeater should be "on air" from its permanent home by the end of June. Serious talks have taken place between the Montreal group and their Ottawa counterparts on the eventual linking of this machine to the Ottawa packet repeater. While the two systems work very differently, the repeaters will serve as Network Interface Machines for the protocol conversion routines. Room has been left on our repeater for additional ports to support a 450 MHZ link if required. This could be the first example of internetworking on Amateur packet.

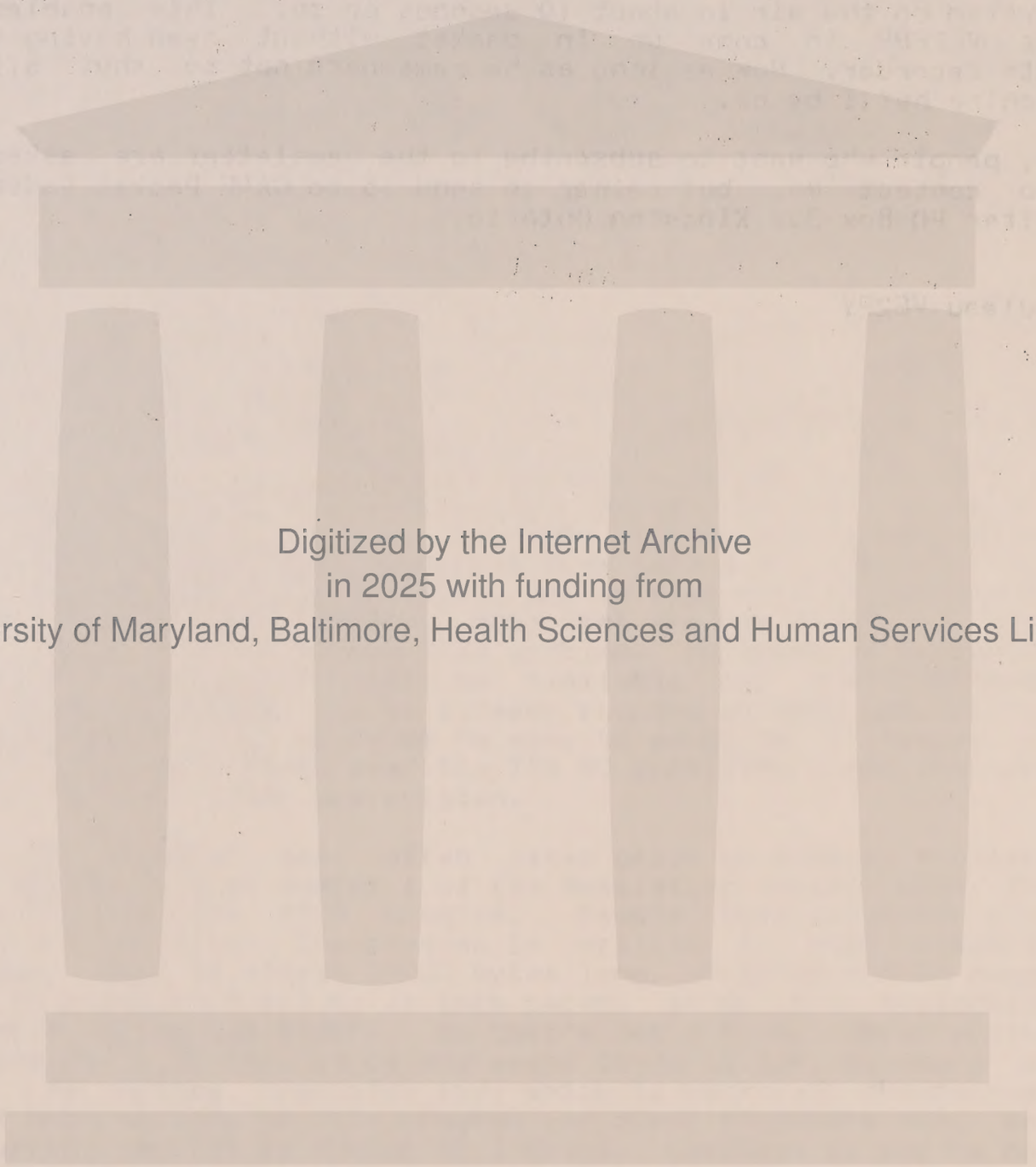
Many questions have been asked about the suitability of various computers for packet radio. While there is no hard and fast rule it seems that a "mainframe" type machine like the SWTP, H8, Horizon,Cromemco or similar is best. The Radio Shack TRS 80 although very popular does have certain limitations due to its architecture. It is difficult to work a proper routine due to the time it takes to scroll the screen on that machine. Everytime something scrolls on the screen, the entire screen memory must be re-written, and this does take time. This is not repeat not an impossible obstacle, but it does make things harder than on a "mainframe" machine. Note that the new Model II from Radio Shack does not have this problem. Software to implement the "Montreal Protocol" will be available for 8080/8085/Z-80 CPU's later this year. It is already running on 6800 and 6809's. The 8080 version will no doubt be easy to adapt to a number of different systems, maybe even the TRS 80 providing a new keyboard scan and screen driver are written.

The last question most often asked based on letters received after publication of Number 1 of the Newsletter deals with the complexity of the 6800 program. People have asked for flow charts and the like. The program is written in 6800 assembly language, and is almost 29000 bytes long. Printed out it needs about 33 pages of 8 1/2 by 11 inch paper. It is the brainchild of Phred Basserman VE2BQF. No that's not a typo. Phred writes programs for a living, at CN and seems to do it for pleasure as well. He writes beautiful code which is very well documented. He has been working on this program for about 18 months now, and the current version is number 39 I think. Needless to say he has put a lot of work into this project and is one of the backbones of the Montreal group. Phred's programs are constantly improving, and the latest versions are designed for use on the super powerful MC6809 processor. Phred's flow charts are usually drawn on 17 inch wide console paper, and the last one I saw was about 30 feet long. Needless to say duplication would be difficult. As a "programmer par excellence" Phred is entitled to special priveleges, notably, temper tantrums when one of us tampers with his code. He gets unusually upset if we complain

to him when one of our modifications to his program bombs.
Can't figure why, but he does. The assembled machine code version of this program is only about 3000 bytes long so it fits easily into machines with as little as 4K of memory. Norm VE2BOS came up with an ingenious method of loading the program into any SWTP system on the air in about 10 seconds or so. This enabled Jacques VE2EHP to come up in packet without even having a cassette recorder. Now as long as he remembers not to shut off the machine he'll be ok.

Lastly, people who want to subscribe to the newsletter are asked not to contact me, but rather to send $5 to CARF Packet Radio Newsletter PO Box 356 Kingston Ontario.
73

Bob Rouleau VE2PY



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Amateur Digital Packet Radio in Ottawa

In early June, 1979, Larry Kayser (VE3QB) button-holed a couple of his friends (Hugh Pett, VE3FLL; Stan Kazmiruk, VE3JBR) and said "You are going to help me put packet radio on the air in Ottawa". Those of you that know Larry will recall that he has a certain "presence"; this makes it kind of hard to refuse!

The immediate target was the July meeting of the Ottawa Computer Group, at which there was to be a demonstration of packet radio. That left 28 days to put together a transmitter (with modulator), receiver (with demodulator) and programs to run in two computers. Through a lot of hard work, and some luck (especially in the computer aspect), the demonstration was successfully held, using an RF link in one direction (range: .7 meters), and a wire in the other.

The first week of work established criteria to be used in the creation and operation of the packet radio system. In approximate order of importance, these were:

1) use state-of-the-art technology, including:
   a) minimum 9600bps data rate
   b) maximum 25khz RF channel bandwidth
   c) control software that can be changed without visiting the site
   d) a repeater operating in a simplex mode.
2) use simple, reproducible hardware
3) allow for large numbers of users

There were obviously countervailing forces in these criteria, since state-of-the-art often implies high-cost, or complex hardware. Even the design parameters contain a conflict, between bandwidth and data rate. The July demonstration showed that by using FSK modulation, the criteria might be met.

Stan (who has been the primary worker in the electronics area) made a circuit that would symetrically FSK the transmitter, and an op-amp slicer circuit to run directly off the discriminator of an old GE TPL FM communications receiver. The RF end of things was Larry's concern, including the building of the transmitter and receiver, and starting to think about a location, antenna and housing for the repeater.

It was agreed from the outset that this packet radio system would be a controlled one, with a repeater to give the greatest possible coverage. This meant that the repeater would have to be intelligent, and that it would be in moment-to-moment control of the system. This led to the requirement for a method of sending the repeater's computer a new control program whenever required, for example: to add new users to the system.

Hugh worked out a simple protocol for polling system users. Polling was selected as the easiest way of maintaining control of the system, especially with large numbers of users. The protocol was designed to ensure that all users could pass traffic, even if there were hundreds of users. In working out the first version of the software, he noticed that ordinary transmit/receive delays (using relays) were long relative to the time required to send a packet (about 50 or 100 msec. vs. 16msec.). This would have drastically reduced the effective throughput of the system, in some extreme cases by as much as 90%. The solution was obvious: shorten the T/R time delay to about 1 or 2 msec., using a diode switcher. Another of the early group members, Graham Ide (VE3BYT), found a circuit for a T/R switch using PIN diodes that seemed likely to be suitable.

After the July demonstration, work continued most heavily on the software. The first version (written in BASIC, with an Assembler subroutine) would quite predictably fail after a few hundred packets. A great deal of work was needed to whip the control program and user program into shape. Concurrently, Hugh developed the software for the loading of the control program into the repeater computer, from a control station. By early October the software was reliable enough to give a demonstation of the full range of capabilities, including loading the control program, polling, sending a message via a packet, and acknowledging the packet. The major reliability problem was the H-8 front panel interrupt servicing, as it interacted with the packet interrupts. Hugh eventually went to a totally non-interrupt form of software, which ran several million packets without failure before he took down that test (about 5 days long).

During this time, the principle electronics problem had been ensuring that the D.C. component of the FSK signal coming from the discriminator was precisely compensated for (ie, that the receiver was tuned within about 100 cycles). Failure in this resulted in errors quickly appearing in the relative lengths of 0 and 1 bits, making signals unreadable. The difficulty arose because the Jury-rigged receiver used up to then had a very narrow IF, and the signal from the discriminator was a distorted sine wave. Extra bandwidth was needed, preferably up near the limit available to us in the 222.34mhz channel, namely 25khz. Stan had constructed a circuit which would track the DC component very precisely, but only if the signal could swing far enough, fast enough (ie in a wide IF). All this discussion may seem unnecessary, but in normal operation each transmitter will be at a slightly different frequency relative to the receiver. For the repeater at least, a signal tracking capability is mandatory; individual users may find it acceptable to adjust their receivers once in a while, but the repeater must compensate for different user transmitter frequencies in at most a couple of milliseconds.

Other activities also continued. The repeater computer was assembled from Larry's Mod80 computer system, power supply from Goodwood Data Systems, and a programmable serial I/O port built by Stan. This was installed and put into operation in a beacon mode (no reception) on December 12, 1979, operating out of Hugh's basement. The next morning, Hugh asked DOC to verify that the transmissions met the regulations for the channel, and was pleasantly surprised to find that it occupied only 7khz, at 30db down.

At this point no one had yet received the signals in digital form over a long distance. Ted Baleshta (VE3CAF) mentioned that he planned to make an effort to detect the signals over the Christmas holidays. He worked to determine the best way of modifying the detector circuitry in his receiver, to effectively increase the IF bandwidth. He succeded quickly in getting a usable digital signal, and built a slicer circuit to translate it into RS-232 levels. Connecting this to a 9600bps terminal confirmed that data was arriving, reliably. Ted suggested two changes: increasing the deviation to get a better signal-to-noise ratio, and the use of a different character for UART synchronization. The result was virtually error-free copy, on 1 watt, at a range of over 7 kilometers, using the inexpensive kits from VHF Engineering.

Packet radio was on the air in Ottawa!

There are other aspects to a system such as this. There has to be a site for the repeater, and the construction, installation etc. of an antenna. Hew Lines (VE3DWL), Frank Stratton (VE3JBB), and Graham have prepared the site, along with others in the group. The controller and transmitter were moved there February 10, to allow valid path testing by the other amateurs with receivers around the city.

And the work went on. Details such as the transmitter turn-on and turn-off times had to be checked (they are less than 1 millisecond), and the PIN diode switch was installed.

The Future

The next few months are certain to produce changes, problems and lots of learning. Hugh is currently heavily into modelling the repeater operation, with special attention to the protocol to be used. It is already clear that slight changes to the protocol will nearly double the effective throughput in most circumstances, while still guaranteeing each user rapid access to the system. The simulations show that even with 200 users, a given user would never have to wait longer than 30 seconds to send his first packet of the day, and that thereafter he would have an equal shot at sending packets.

As more and more people begin using this packet radio system, there will be a number of experiments carried on. Some are set already, including the use of telephone links to permit some use of the system by people that don't have radio equipment. Also, attempts will be made to link this system with others, say in Montreal (using a relay station) and Vancouver (using HF RTTY). There will be many more ideas tried out.

This system will evolve to some extent, by consensus. Different protocols will be tried, and probably higher data rates (with IF bandwidth again being a major limiting factor).

After using this rather general-purpose system for a while, it is likely that some users will want a greater or different capability. This will lead to one or more additional systems being established, with unique operating characteristics. Hopefully, new systems will link to earlier ones, to allow users on one to communicate with users on the other(s).

Initial Protocol for Ottawa Packet Radio

Purpose

This protocol is intended to be a medium-efficiency, easily implemented protocol. It will be used on the Ottawa Packet Radio repeater VE3RMR until a new protocol is agreed on by users of VE3RMR.

General Description

This is a polling protocol, operated by the stored program controller at VE3RMR.

The control program (CP) contains a list of amateur licence callsigns which may use the repeater. Any licenced amateur is permitted access, by prior arrangement.

The CP polls each callsign in its list, in turn, requesting traffic. Traffic consists of a packet, in a standard format.
The called station does one of two things:sends traffic, or remains silent.

When a station sends traffic, it is labelled "active" by the CP (the concept of "active" is explained later). Each time an "active" station remains silent, its "active" label is "eroded". Eventually, after a number of silent responses, an "active" station has its label completely "eroded", and then is labelled "inactive". Erosion of an active label also occurs (VERY rapidly) if a station uses an invalid address on a packet, or continually tries to send to a station that doesn't respond.

Each packet that a station sends is acknowledged by VE3RMR, in one of the following ways:

1) accepted by the addressed station (ACK)
2) not accepted by the addressed station (NAK)
3) addresses station did not reply (NOTAVL)
4) bad address used (BADADR)
5) refused by the addressed station (REFUSED)

If a packet is ACKed, the sender is labelled fully "active", and the addressed station is labelled fully "active". In all other cases, the sender's "active" label is eroded, by varying amounts depending on the severity of the problem.

Active vs. Inactive

The only difference between an active and an inactive user is that active users get polled more frequently for traffic. As an example, a CP with 100 callsigns might poll each inactive callsign once every 6 seconds, but would be polling each of 10 active callsigns once every 2 seconds.

This scheme adapts to the load, allowing everyone access within a guaranteed and reasonable time span, while sharing the channel equally among those stations sending traffic regularly. In the extreme case, of all callsigns being active, each would be polled at least every N/2 seconds, where N is the number of valid callsigns.

Each user may send up to 240 characters of data each time he is polled, to any other valid callsign. Each user is responsible for ensuring that his station program can deal with arriving packets, refusing some if necessary (for example, if he is receiving a lot of connected data from one user, he probably would not want any other data in the middle.)

It is certain that application-oriented protocols will be defined to facilitate specialized tasks, such as file transfers. These would in effect redefine the 240-byte data area, and would be used by those wishing that function. The basic repeater protocol will remain as simple as possible, in order to allow many different uses.

Technical Description

There are 9 types of packet. Each has a fixed-format header of 16 bytes. A traffic packet has an additional data area of 0 to 240 bytes. The maximum length of a packet is therefore 256 bytes.

Type	Name	Length
1	refused to accept (REFUSED)	16
2	traffic (transmitted by user)	16-256
3	bad address (BADADR)	16
4	traffic (transmitted by repeater)	16-256
5	not accepted (NAK)	16
6	accepted (ACK)	16
7	reception shutoff (SHUTOFF)	16
8	not available (no reply) (NOTAVL)	16
9	request traffic	16

Packet Preamble

To allow for transmit/receive switching, power on, etc., each packet is immediately preceded by from 2 to 6 synchronizing characters (hex FF) and a hex 00. The precise number of sync characters recommended will be determined experimentally during early operational use.

Packet Format

Byte	Name	Description
1	length	the length of the packet, less 1 (maximum 255)
2	type	the packet type (1 through 9)
3to8	address	the call sign of the station to which the packet is being sent
9to14	sender	the call sign of the station from which the packet is being sent
15,16	CRC	the 16-bit CRC for the entire packet
17-256	data	traffic packets may have from 0 to 240 bytes of data

Notes

1) the first two bytes are binary, all eight bits valid.
2) bytes 3 through 14 are standard ASCII, with high-order bit=0.
3) bytes 15 and 16 (CRC) are binary, all eight bits valid.
4) data is assumed to be binary, all eight bits valid.

Packet Sequences

Normal Traffic Sequence

1) VE3RMR sends type 9 packet to station1
2) station1 sends type 2 packet, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) station2 sends type 6 to VE3RMR
5) VE3RMR sends type 6 to station1

No Traffic Sequence

1) VE3RMR sends type 9 to station1
2) station1 remains silent. After about 10 msec. VE3RMR proceeds to poll the next callsign.

Bad Address Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR does not find "station2" in its table of callsigns, and sends type 3 to station1

Refused Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) station2 sends type 1 to VE3RMR
5) VE3RMR sends type 1 to station1

Not Available Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) VE3RMR waits a short time (10msec.), but receives no reply
5) VE3RMR sends type 8 to station1

Not Accepted Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) station2 detects an error, sends type 5 to VE3RMR
5) VE3RMR resends type 4 to station2
6) station2 detects an error, sends type 5 to VE3RMR
7) VE3RMR resends type 4 to station2
8) station2 detects an error, sends type 5 to VE3RMR
9) VE3RMR sends type 7 to station2
10) VE3RMR sends type 5 to station1

CIRCUIT DIAGRAMS

A couple of cautions about the following circuit diagrams should be made: they are the initial operational versions, and could change slightly in the future; they are rather dependent on the equipment used for the transmitter and receiver. as you will see, the equipment consists of highly-modified VHF Engineering circuit board kits; the relevant descriptions use the part numbers in the kit documentation. The totally new circuits (all Stan's work) are the demodulator/ tracker circuit, and the PIN diode switcher/transmitter keyer; the modulator is adapted from a design developed some years ago by Larry.

Unfortunately, Stan has not yet optimized the demodulator circuit, and wishes to work on it further before releasing it for publication. See the note following, and write him to get on the mailing list for this circuit, and some technical documentation.

It is hoped that the new circuits will be available soon as PC boards, with parts suppliers listed. For more information, send a stamped, self-addressed envelope to Stan, 2448 Orient Park Dr., Ottawa, Ont K1B 4N1.

FUTURE PACKET RADIO NEWS

Please write Hugh Pett if you would be willing to pay a couple of dollars a year for 3 or 4 newsletters. For now, C.A.R.F. is graciously providing duplication and mailing, but an indication of "real money" interest would help guage keenness on this topic. You will notice that a list of all recipients of this first newsletter is attached: do get in touch with one another, and do something with packet radio!

TRANSMITTER CIRCUIT

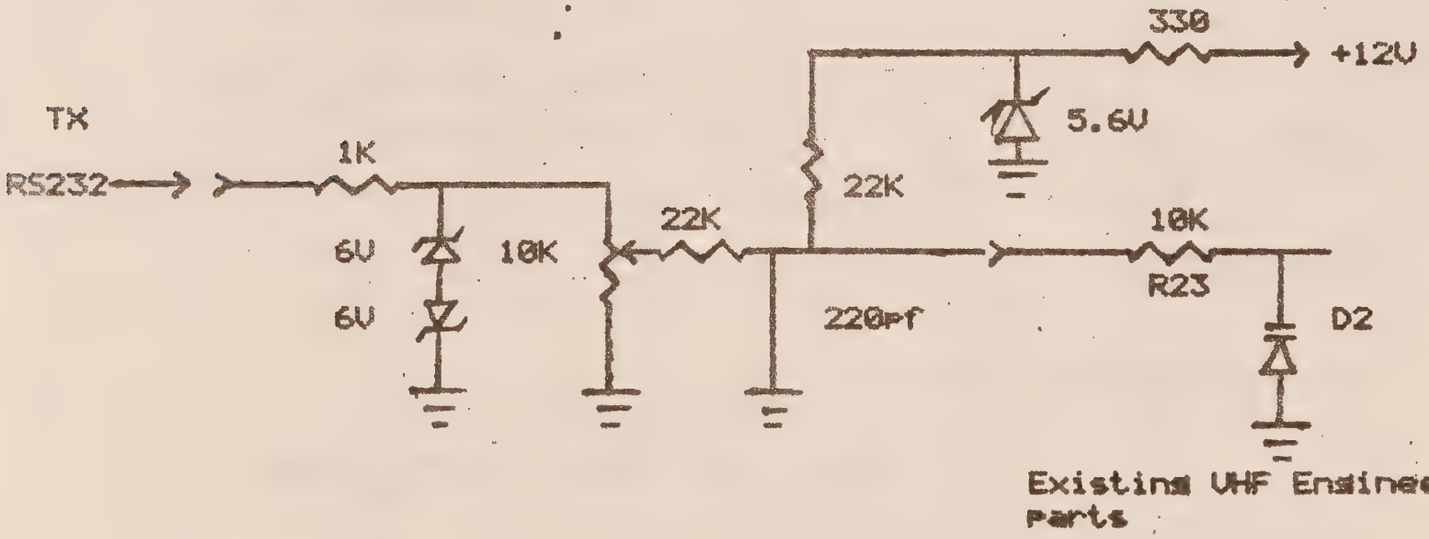
NB- all part labels refer to VHF Engineering Kit TX220B

Parts to be deleted

R10	470K	R11	4.7K	R12	1.2K
R13	1.2K	R14	4.7K	R15	27K
R16	4.7K	R17	1K	R18	4.7K
R19	4.7K	R20	5K pot	R22	47K
R25	22K				
C27	4.7MFD	C28	.001	C29	4.7MFD
C30	4.7MFD	C31	.01	C32	4.7MFD
C33	.01	C34	.01	C35	.005
C36	.01	C37	.001		

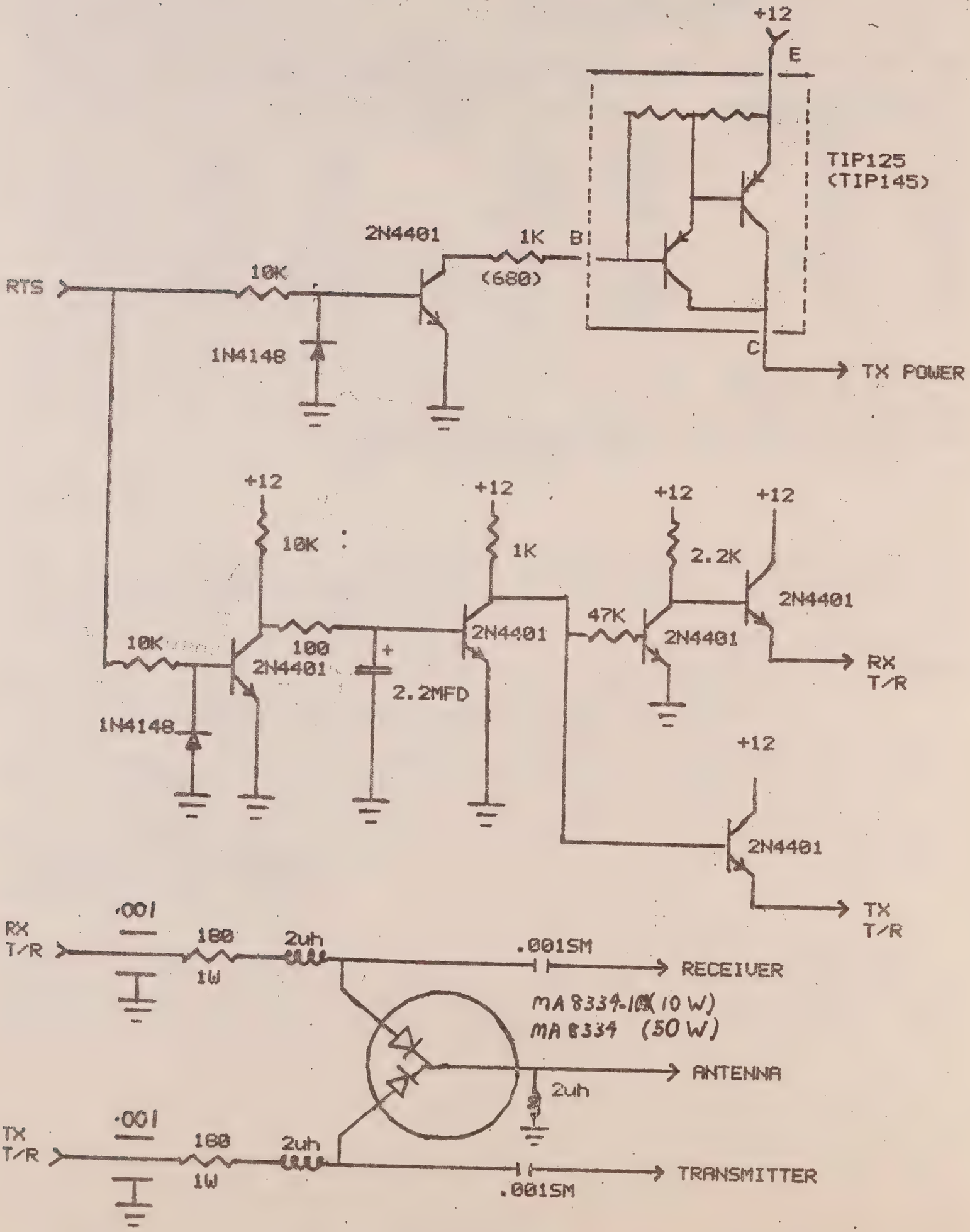
Parts to be changed

C20 from 4.7MFD to 2 MFD (preferably tantalum)
C26 from 100MFD to 2 MFD (preferably tantalum)



Existing VHF Engineering parts

TRANSMIT/RECEIVE CIRCUIT



DIGIPEATER HARDWARE

This article describes the digital radio equipment currently used in the Ottawa Digipeater and in several of the terminal stations now operating in the Ottawa area. Some of the items in this article were partially covered in the last issue of this newsletter--certain material is repeated here for the sake of completeness and in order to correct several minor errors in the previous issue.

Design Objectives

Very early in our planning for Digipeater, various design objectives were established, based on our concepts of how such a system could best fulfill the needs of an anticipated rapidly growing community of interested users. A wide variety of factors were taken into consideration such as the number of users who could reasonably share a radio channel, the range of response times that could be expected under varying conditions of system loading, the complexity, cost and availability of suitable equipment, the radio bandwidth and spectrum requirements, and, generally, the state-of-the-art in hardware of this type. Obviously, the choice of design parameters involved a number of compromises and tradeoffs. The main criteria and parameters selected were:

a) operation within the 25 KHz bandwidth allocated in the 220 MHz band

b) single frequency simplex mode operation

c) 9600 bps data rate

d) transmit/receive switching in approximately 1 msec.

e) simple modulation/demodulation scheme - NRZ data, FSK (frequency shift keying, F1 modulation)

f) standard RS-232 digital interface between radio equipment and computer/terminal

g) easily reproducible hardware

h) control software at repeater remotely reloadable and changeable at any time without need to visit repeater site

i) repeater must always "land on its feet", eg.-repeater operation restored automatically following a power failure; various failures inititate an automatic reload of software from the control station

In selecting the above parameters, our primary goal was to achieve the highest speed, performance and efficiency possible within reasonable limits of complexity and cost in order to avoid overloading of the system and degradation of performance as the number of users and volume of traffic increased.

We believe that a single Digipeater properly designed within the above criteria would satisfy a group of one hundred or more local users for a number of years. Of course our group and others will also be looking at the possibilities inherent in the 100 KHz bandwidth allocations, but we see these as being most useful for more specialized applications such as digitized voice, digitized video, and other esoteric pursuits.

Many of the above criteria have design implications for every component of the system, including the radio equipment and the computer hardware and software at both the repeater and terminal stations. However, this article deals mainly with the radio equipment and the digital/radio interface.

Basic Functions

A block diagram of a basic Digipeater terminal is shown in Fig. 1.

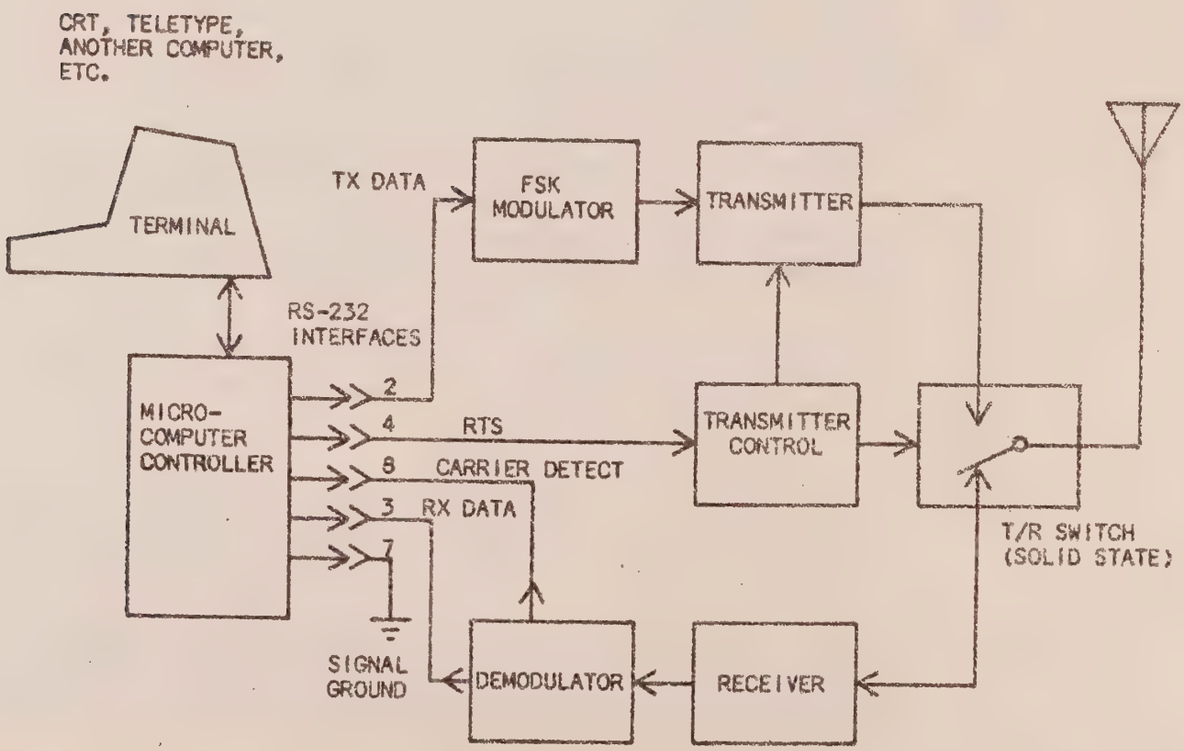


Fig. 1 - Basic Digipeater Configuration

It should be noted that the repeater hardware is virtually identical to that of a terminal station except that the CRT or Teletype terminal is not required at the repeater, and the software in the microcomputer controller is different. In fact, any terminal station could perform the basic functions of a repeater simply by loading the appropriate software in its computer. In practice, however, a fully implemented Digipeater will have several additional hardware features such as a watchdog timer (which helps ensure a computer reset and program reload in the event of program failure) and a real-time clock/calendar (soon to be implemented in our Digipeater). Additional control and interface features may be added eventually as we gain experience with the system.

To the microcomputer, the radio equipment to the right of the RS-232 connector in Fig. 1 looks very much like a standard asynchronous half-duplex communications modem operating at 9600 bps. Several of the usual modem control lines (CTS, DSR, DTR, etc.) were not implemented because they were not needed. However, if necessary, they could easily be added in future versions of this equipment.

When the microcomputer wants to transmit, it turns ON the RTS (Request to Send) control lead which activates the transmitter control circuit, applies power to the transmitter, and switches the antenna from the receiver to the transmitter. The RLSD (Receive Line Signal Detect) signal is derived from the squelch circuit in the receiver. It is not currently used by the terminal station computer, but it may be required in certain repeater applications.

Before going into a detailed description of the radio components, a few general comments on our choice of radio equipment might be appropriate. Without question, the easiest and fastest approach to transmission and reception of digital data would have been to start with a standard 220 MHz FM transceiver and use a simple modem or similar digital-to-audio tone modulation/demodulation scheme. This approach was examined and rejected for the following reasons:

a) The audio bandwidth of a typical transceiver would limit the maximum practical data rate to about 2400 bps.

b) The transmit/receive switching of a typical low cost amateur transceiver uses a mechanical relay which, aside from being too slow (the switching times would be a significant portion of the time to send a packet), would have a short life because of the frequent and rapid switching required.

c) The IF bandwidth of most modern transceivers is somewhat too narrow for 9600 bps modulation (more on this later).

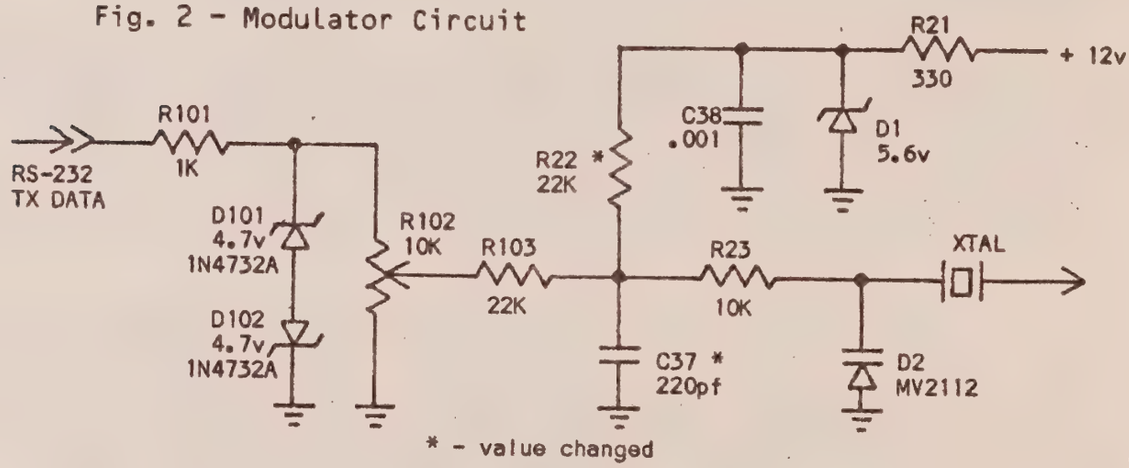
d) The squelch circuitry of a typical transceiver includes time delays which are excessive for rapid turnarounds.

Faced with the likelihood of extensive modifications, we felt that it would be easier and more practical, at least initially, to work with modular equipment, preferably in kit form; hence the choice of VHF Engineering products, which were available locally (at least they were at the time). We will be continuing to look at other equipment which may be more suitable for our purposes.

Transmitter

The transmitter module is a VHF Engineering Model TX220B, rated at one watt nominal output. The necessary modifications consist of deleting nearly all parts associated with the microphone input and audio modulator and replacing them with the circuit shown in Fig. 2. In addition, two electrolytic bypass capacitors are changed to lower capacity tantalum devices to reduce the turn-off time of the transmitter when DC power is removed.

Fig. 2 - Modulator Circuit



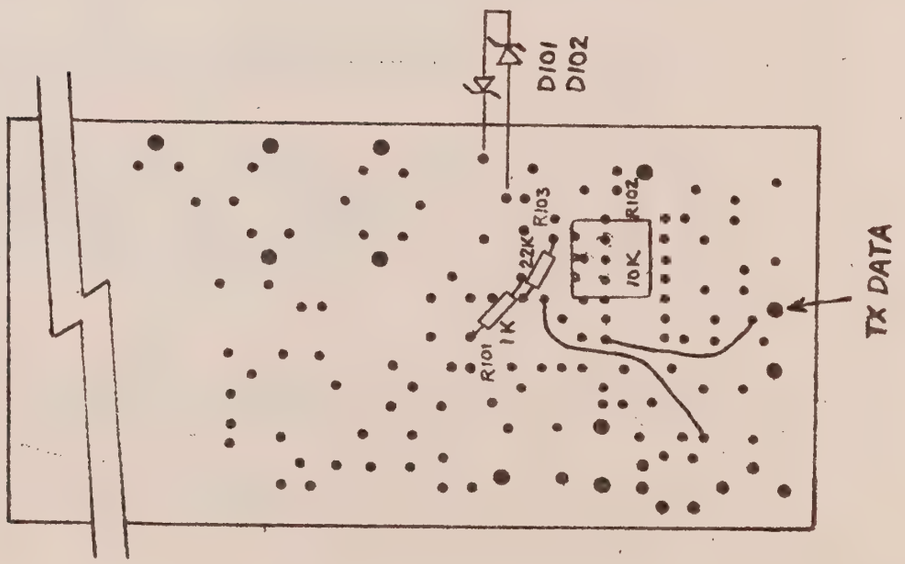


Fig. 3 - Physical location of parts added on TX220B circuit board.

Fig. 4 - Parts Lists - TX220B modifications

Parts to be deleted:

R10 - 470K		R11 - 4.7K		R12 - 1.2K	
R13 - 1.2K		R14 - 4.7K		R15 - 27K	
R16 - 4.7K		R17 - 1K		R18 - 4.7K	
R19 - 4.7K		R20 - 5K pot		R25 - 22K	
C27 - 4.7 mfd		C28 - .001mfd		C29 - 4.7mfd	
C30 - 4.7 mfd		C31 - .01 mfd		C32 - 4.7mfd	
C33 - .01mfd		C34 - .01 mfd		C35 - .005mfd	
C36 - .02mfd					

Parts to be changed:

R22	from 47K	to	22K
C37	from .001mfd	to	220pf
C20	from 4.7mfd	to	2.2mfd tantalum
C26	from 100mfd	to	2.2mfd tantalum

Parts to be added:

R101	-	1K
R102	-	10K pot, Bourns 3386P-1-103 or equiv.
R103	-	22K
D101	-	1N4732A zener diode, 4.7v
D102	-	1N4732A zener diode, 4.7v

The circuit shown in Fig. 2 is an extremely simple direct FSK modulator. The only restriction is that the RS-232 Transmit Data signal must be +/- 6 volts or greater for consistent modulation levels. Most common RS-232 interfaces use +/- 12 volts which is ideal. D101 and D102 clip the incoming signal to about +/- 5.4 volts, and R102 serves as a deviation adjustment. Frequency shifts up and down from the "centre" frequency (0 volts on TX Data) are not exactly equal for positive and negative inputs (the modulator is not quite linear) -- this is of no consequence because the "centre" frequency is not used in normal operation; however, when testing or adjusting the transmitter frequency, it must be kept in mind that if the RS-232 input is disconnected, the "centre" frequency will not be the mid-point between the Mark and Space frequencies. This will be discussed more fully later under adjustment procedures.

For higher power output, the transmitter can drive a 10 watt amplifier, which we are currently using at the repeater. However, as a general principle, we are encouraging users to stay with lower power and use a better antenna if performance is marginal. We expect that in the near future, our repeater will be moved to a better site and equipped with a better antenna, at which time we will experiment with lower power at the repeater.

T/R Switch and Transmitter Control

Fig. 5 and Fig. 6 show the schematic and PCB layout for the T/R switch and transmitter control circuits. When RTS turns ON (positive), Q2 applies DC power to the transmitter, Q6 turns OFF and Q7 turns ON, instantly switching the antenna from the receiver to the transmitter. When RTS switches OFF (negative), Q2 removes DC power from the transmitter instantly, but because of several bypass capacitors in the transmitter which retain a charge, the transmitter will continue to operate briefly. Therefore, R4, R5 and C1 provide a slight delay (approximately 1 msec) before the antenna switches back to the receiver.

The MA8334 is a PIN diode device, manufactured by Microwave Associates, Inc., especially designed for VHF-UHF transmit/receive switching. The TO-5 version used on our PCB is rated at 15 watts and a larger version rated at 50 watts (continuous ratings) is available. The device has a nominal 50 ohm impedance and is designed for operation from 20 to 1000 MHz. Typical insertion loss is 0.2 db with 1.2:1 vswr from 20 to 500 MHz. Isolation between ports is specified at around 33 db at 220 MHz. The actual isolation and vswr achieved will depend on additional factors such as choice of other components, PCB layout, etc. To operate a switch path, approximately 50 ma. (minimum) forward bias is applied; removal of the current releases the switch path. The device is specifically designed so that reverse bias is not required. Harmonic output meets standards for commercial radio applications, according to the manufacturer. The use of a somewhat higher bias current (approximately 70 ma in this case) helps minimize harmonic generation.

The above characteristics make the device nearly ideal for our application. The only catch is that the device is not readily available in small quantities. Test samples were generously provided to us by the Canadian office of Microwave Associates, and, with their assistance, we are currently looking into a regular source of supply through a U.S. distributor that handles MA products.

L1, L2 and L3 consist of about 32 turns of #28 enamel wire close-wound on a 3/16" drill rod or other temporary form (makes rather flimsy coils that require careful handling, but they are fine after they are soldered into the PC board).

Q2 does not require heatsinking. For higher current switching, use of the larger TIP145 is necessary to avoid excessive voltage drop across Q2. The circuit board is designed to accept either the TIP125 or the TIP145.

Note: R11, shown on the schematic but not on the PCB layout, was added to ensure that the transmitter remains OFF when the RS-232 connector is removed or the computer power is switched OFF. Users who have one of the earlier PC boards should add this resistor externally -- otherwise, you can create all sorts of nasty QRM (as we discovered!!). R12 and the XMTR ON indicator were also added later. The next version of the PC board will include R11 and R12.

Fig. 5 - T/R Switch and Transmitter Control

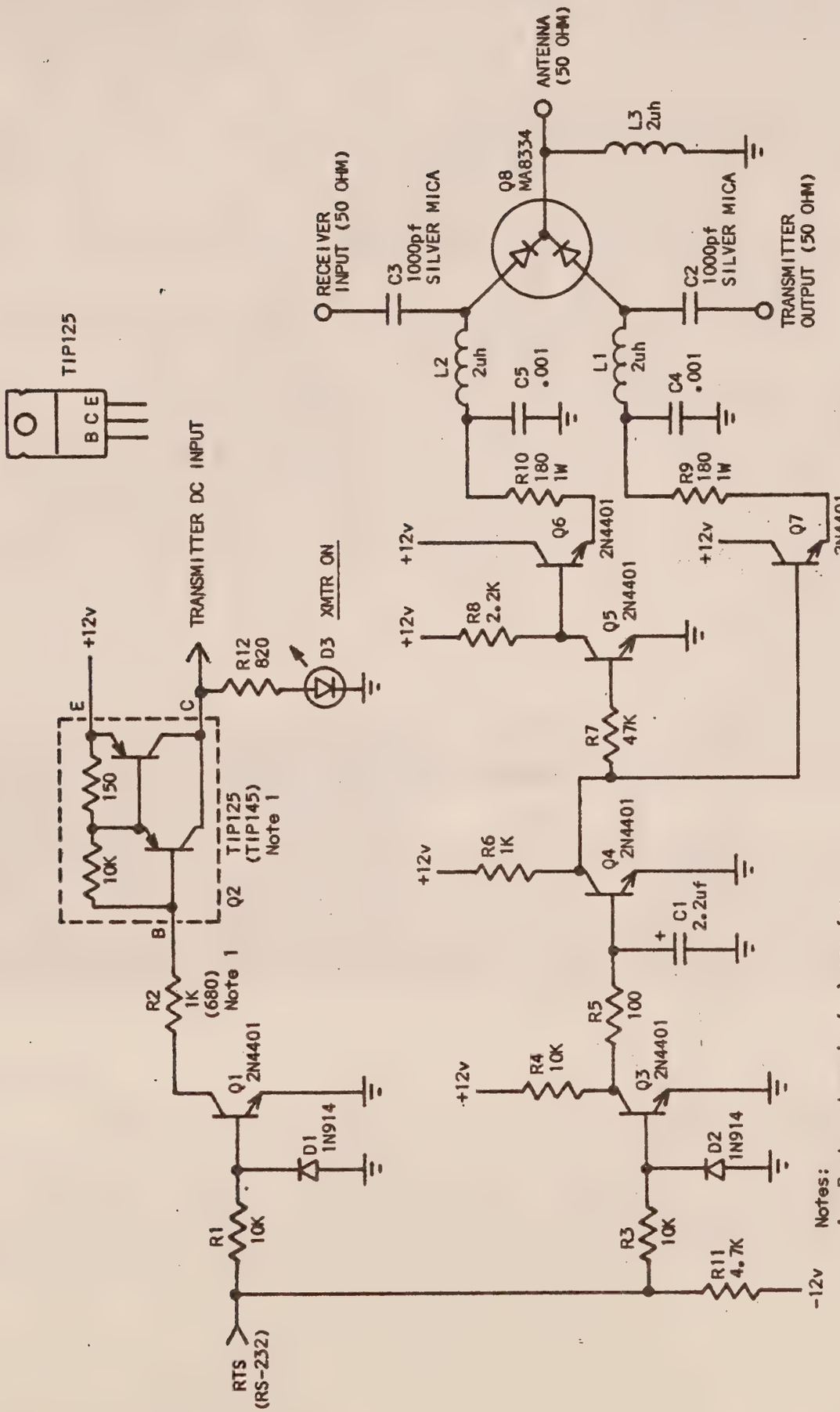
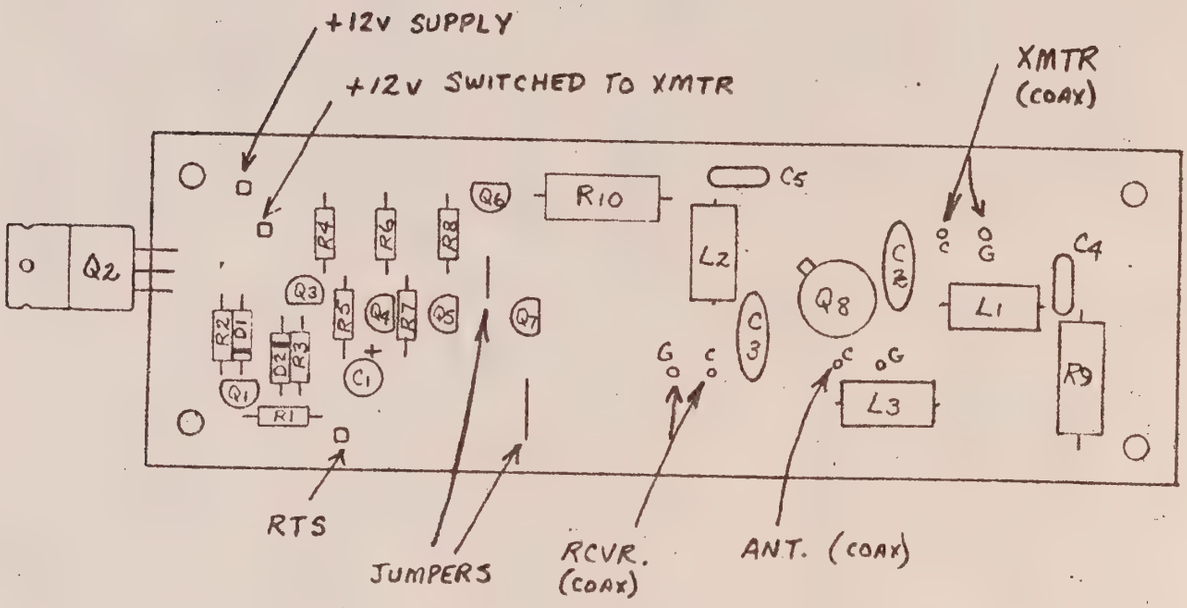
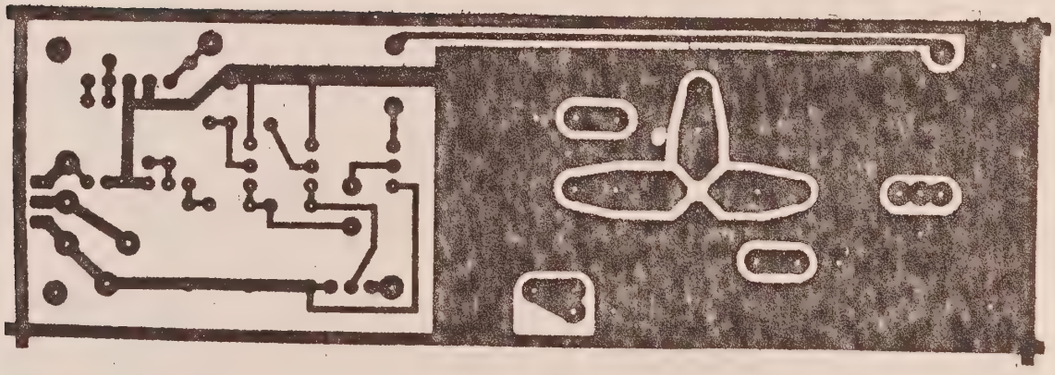


Fig. 6 - PCB Layout - T/R Switch and Transmitter Control





Receiver

A 220 MHz audio receiver made up of VHF Engineering components normally would consist of 4 modules, the 220 MHz front end, a 10.7 MHz IF strip, a 455 KHz IF strip, and an audio/squelch board. We used the first three of these modules:

RF220D - Front end (output is 10.7 MHz)
IF10.7 - 10.7 MHz IF strip (includes 2nd converter stage)
FM-455A - 455 KHz IF strip (includes limiter and FM discriminator stages)

In place of the VHF Engineering audio/squelch board, a specially designed demodulator board was used (to be described later).

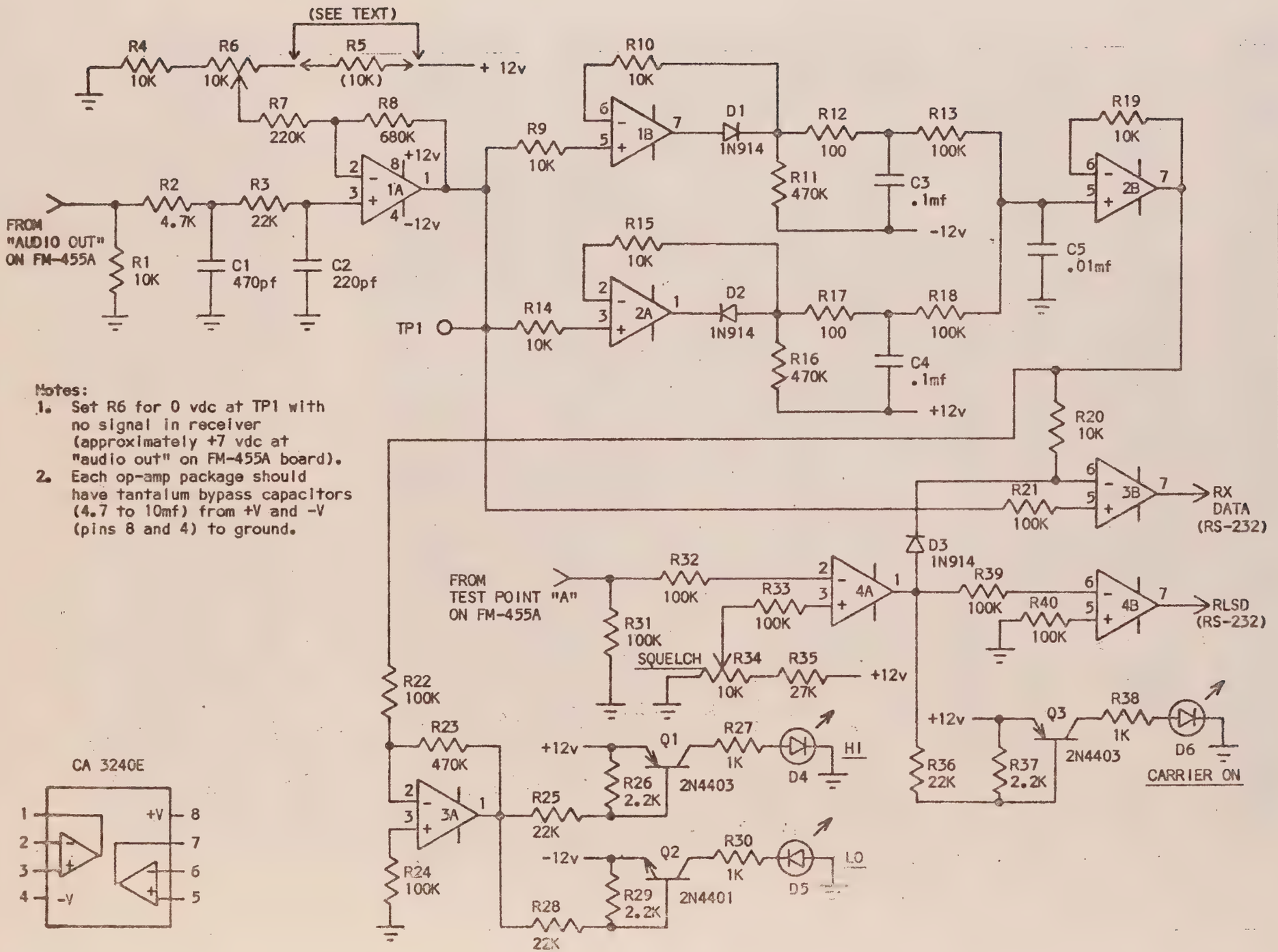
The front end and 10.7 MHz IF modules did not require any modifications (at least no functional changes).

Several minor changes were required to the FM-455A module. Firstly, we found that the IF bandpass characteristics needed improvement for optimum operation with 9600 bps modulation. The skirt selectivity is not exceptionally narrow, but the presence of 4 IF transformers at 455 KHz (one on the 10.7 IF board and three on the 455 KHz board) produces a peaked response which is too narrow at the top. Attempts to stagger tune the transformers were not especially successful. The response was broadened by removing T3 from the circuit. After physically removing the transformer from the board (or not installing it to begin with if you start with a kit) a slight modification must be made to the PC board (accomplished more easily before T2 is mounted). This consists of cutting and removing the ground foil around the grounded pin of the secondary of T2 with a drill or Dremel tool, and connecting jumpers from the secondary pins of T2 to the foil connections for the secondary of T3. Thus the secondary of T2 now connects to R2 and the input of IC2. The overall IF bandpass is still not ideal but is workable.

In addition, C11 is changed from .022mfd to 220pf, and C14 is changed from 68pf to 47pf. C11 ordinarily provides audio de-emphasis. Reducing its value minimizes distortion of the discriminator output waveform (in fact, with the selected value of C11, a fair amount of 455 KHz carrier remains in the audio output. It is removed by additional filtering at the input of the demodulator board).

Demodulator

The schematic circuit of the demodulator board is shown in Fig. 7. Basically, the function of this circuit is to take the output of the discriminator (which, after filtering, looks more or less sinusoidal for single bit transitions) and square it up to produce a digital RS-232 output signal. In addition, it provides a carrier detect signal (Receive Line Signal Detect, RLSD, in RS-232 terms), a squelch function, and several LED indicators.



Notes:

1. Set R6 for 0 vdc at TP1 with no signal in receiver (approximately +7 vdc at "audio out" on FM-455A board).
2. Each op-amp package should have tantalum bypass capacitors (4.7 to 10mf) from +V and -V (pins 8 and 4) to ground.

Fig. 7 - Demodulator Schematic

The output of the discriminator appears at the "Audio Output" point on the FM-455A board. As mentioned earlier, the output of the modified FM-455A contains a component of the 455 KHz IF. The filter formed by R1, R2, R3, C1 and C2 removes the 455 KHz frequency component with minimal effect on the "audio" waveform. When the discriminator is properly aligned the audio output is centred on approximately +7 volts DC (not +5 volts as the VHF Engineering documentation suggests). The first op-amp, IC1A, amplifies the "audio" signal by a factor of about three times, and adjusts the DC level of the signal. R6 is set so that the output at Test Point TP1 is centred on 0 volts DC. This adjustment is not particularly critical; it merely provides maximum tolerance for acceptance of off-frequency signals. (Note: R5 is not used with the FM-455A board (R6 is connected directly to +12v). This demodulator circuit can also be used with other types of FM discriminators, but changes may be required to the input circuitry associated with IC1A. If a conventional discriminator is used, the output will normally be centred on 0 volts DC. In this case, R5 must be included to give an appropriate adjustment range for R6.)

At this point, if the incoming signal were perfect, all that would be required would be to square up the waveform at TP1 and we would have the desired digital signal. To avoid distortion of the digital bit pattern, it is necessary to "slice" the recovered "audio" signal at its exact midpoint, as shown in Fig. 8. (In our earliest experiments, we used a very simple slicer, a single op-amp with a pot to manually adjust the slicing level.) In practice, frequency errors and drift in both the receiver and the transmitter will cause the DC level of the recovered signal to shift up and down by a considerable amount. In fact, in some cases, we found a significant frequency change occurred during the sending of a packet -- a sort of "chirp" as the DC power is first applied to the tranmsitter (remember that the total "ON" time for the transmitter is roughly 50 to 250 msec. to send a packet). Therefore, the demodulator needs an automatic "tracking" circuit to maintain the slicing level at the exact centre of the signal.

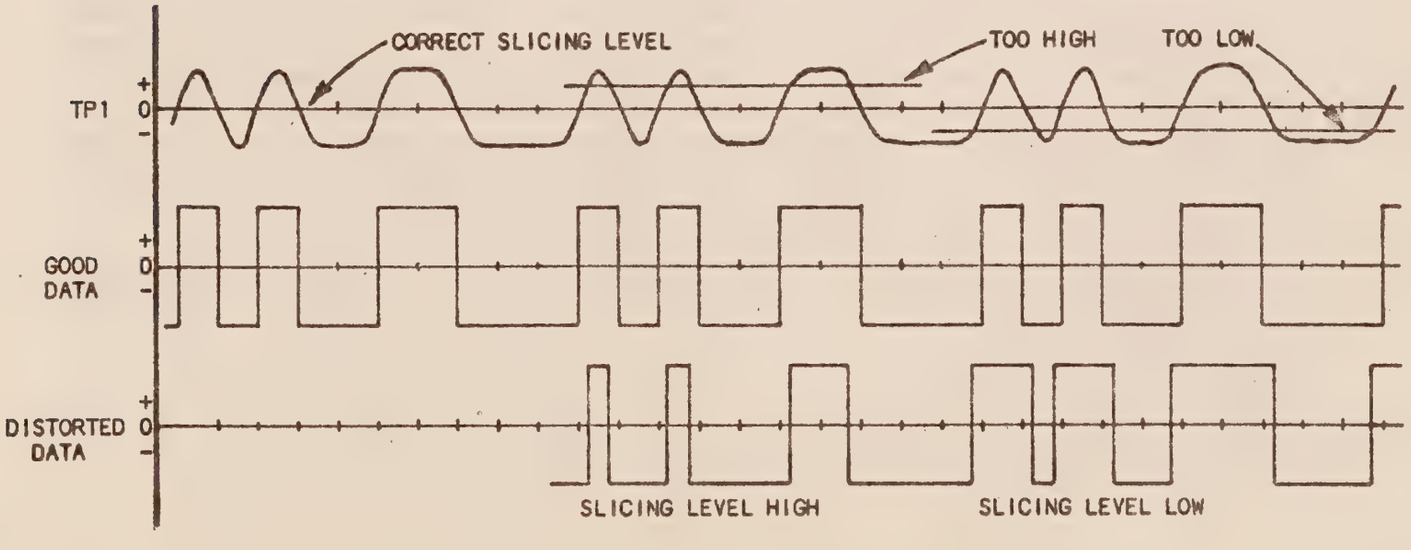


Fig. 8 - Discriminator and demodulator waveforms

IC1B, IC2A and their associated components form positive and negative peak detector circuits with controlled time constants. The outputs of the two peak detectors are fed to a voltage divider made up of R13 and R18. The voltage at the mid-point of R13 and R18 is the mid-point between the positive and negative peaks of the signal at TP1, and, assuming that the signal is reasonably symmetrical, corresponds very closely to the ideal slicing level. The mid-point voltage is buffered by IC2B, and passed via R20 to pin 6 of IC3B, the slicer. The signal from TP1 is passed to the + input of IC3B, and the output of IC3B is the desired digital data signal at RS-232 levels, +/-12 volts.

Test Point "A" on the FM-455A board is a DC voltage intended to serve as a signal strength indicator (the "full scale" voltage which corresponds to full quieting is developed at roughly 10 microvolts RF input signal). This voltage is compared by IC4A with a voltage set by R34, the "squelch" control. If the RF signal level is below the squelch threshold, IC4A clamps the slicer, IC3B, via diode D3, so that noise (garbage data) does not appear in the output (the RX Data lead remains Marking). When the signal level exceeds the squelch threshold, the output is unclamped, the carrier indicator LED comes ON and the RLSD lead switches ON. The combination of R31 on this board and C12 on the FM-455A board establishes a very short time delay in opening the squelch. (Incidentally, we experimented with a noise-operated squelch circuit. It proved to be less desirable because, at 9600 bps, the discriminator output tends to contain high frequency components which are difficult to distinguish reliably from noise.)

The output of IC2B is also used to drive an indicator circuit consisting of IC3A, Q1, Q2, the HI and LO LEDs, and their associated circuitry. When the receiver is correctly aligned, and R6 is set properly, both the HI and LO LEDs will be illuminated if the incoming RF signal is within about 2 KHz of the correct frequency. If the incoming signal (or the receiver front end) drifts high or low by more than about 2KHz, only one LED will be lit, indicating the direction of the error. This circuit was intended to serve as a tuning indicator for the receiver (and transmitter) for users with limited test equipment. In practice, it has proven to be of somewhat limited usefulness because actual frequency errors seem to frequently exceed 2 KHz and, when one observes actual transmissions from the repeater and other stations, the lights flicker so rapidly that one cannot determine what is happening. However, the Carrier indicator LED on the receiver and the Transmit indicator LED on the transmitter have proven to be very useful -- with a bit of practice one can quickly recognize certain patterns of operation and determine whether things are working correctly or not.

Packaging

Because of previous experiences with computers interfering with radios and vice versa, we decided to avoid unnecessary headaches and make our initial packages thoroughly RF-tight. We packaged the transmitter strip and the transmitter control and T/R switch in one case, and the receiver and demodulator boards in a separate case. We used Hammond Model 1590 D cases, which are good quality die-cast aluminum cases with close-fitting flanged covers. Feedthrough capacitors (.001mfd.) were used on all RS-232 signal leads and the power supply leads. Indicator LEDs were mounted in small holes in each case and wired to the appropriate circuit board points. Perhaps this sort of packaging is "overkill", but we experienced no RFI problems whatever, and no interaction between transmitter and receiver. Depending on what sort of equipment we use in the future, we may look at simpler and less expensive cases.

We found during alignment and testing that it was important to have the modules (particularly the receiver boards) properly grounded. The transmitter strip was mounted about 1/2 inch away from the bottom of the case with sheet metal angle brackets soldered to the ends of the board. The T/R switch board may be mounted in the same manner or by means of 1/2 inch metal spacers. The receiver boards were mounted by means of brackets fabricated from thin sheet metal and soldered to the ends of each board. Hobby stores sell small sheets of tin plated metal which is easy to work with and solders beautifully. The brackets extend above and below the board and are fastened to the side walls of the case about an inch above the board (there isn't room to attach them conveniently to the bottom of the case since the boards are almost as long as the case is wide). The brackets also serve as stand-offs when the receiver boards are tested outside their case. When testing in this manner, we obtained best results by placing the boards on a grounded metal surface such as a piece of copper clad PCB material. Final alignment of both the transmitter and receiver should be carried out after the boards are mounted in their cases.

Testing, Alignment and Adjustments

In order to facilitate testing and adjustment, we built a simple transmitter test generator -- a small box containing a power supply, an oscillator, counter/divider and selector switch which generates suitable clock frequencies for the UART, an 8-position DIP switch (on the front panel) which allows transmission of any selected 8-bit character, a three-position toggle switch that places steady Mark, steady Space, or data from the UART on the TX Data lead, several switches to turn various RS-232 leads ON and OFF (the only one currently used is the RTS lead which turns the transmitter ON and OFF manually), and an RS-232 connector which will connect to the transmitter. This generator facilitates a variety of tests on both the transmitter and receiver.

For much of our development work we were fortunate to have available a reasonably adequate collection of test equipment including a scope, frequency counter, VHF signal generator, adjustable RF attenuator, etc., and to have access to more exotic items of equipment on an occasional basis. Hopefully, it should be possible to align and set up the radio equipment without all that equipment, but there are a few difficulties which I will mention.

Initially, we aligned the transmitter according to the manufacturer's instructions (which is a problem I will discuss later). Using the test generator, and setting the output switch alternately to the Mark and Space positions, the deviation should be set up for a shift of 5 Khz (+/- 2.5 KHz) as measured on the frequency counter. If the DIP switch is set to 10101010 for bits 1 to 8, the data output is a square wave, and the frequency counter will read the average or centre frequency of the transmitter. However, because of the "chirp" effect mentioned earlier, which was worse with some crystals than with others, you can't necessarily set up the transmitter frequency with a frequency counter -- the counter reads the frequency after a second or two, but it's the frequency during that first quarter second that counts!! (More about how to get the transmitter on frequency a little later.)

Initial alignment of the receiver is accomplished most easily with appropriate signal generators; however, it can also be done with an off-air signal and using the transmitter working into a dummy load (although for some purposes, such as aligning the front end, the local signal from the transmitter may be too strong). An oscilloscope is almost mandatory for the final alignment procedure. With the front-end and IF strips reasonably aligned, the discriminator is adjusted for the "best" waveform at test point TP-1, using the test generator and transmitter to generate a pattern like those shown in Fig. 8. It may be possible to improve the waveform by touching up the 455 KHz IF alignment a bit. The best waveform will be smooth and symmetrical, with single-bit transitions approximately the same height as sequences of two or three bits. An off-frequency signal not centred in the IF passband causes asymmetrical peaks, and other forms of distortion which will produce erroneous data.

When the discriminator is correctly aligned, with no RF signal input, the signal at pin 3 of IC1A ("audio" output after filtering) will consist of noise with an average value centred at approximately +7 volts DC (can be measured with a DC voltmeter). R6 is then adjusted so that the amplified signal at TP-1 is centred on 0 volts DC. If the transmitter output, with continuous square wave modulation, was previously adjusted to the correct frequency with a frequency counter, its signal can now be used to adjust the crystal trimmer on the receiver front-end so that the signal at TP-1 is centred on 0 volts DC (or both LEDs are ON). The result should be a correctly aligned receiver and demodulator.

The correctly aligned receiver can now be used to correct the transmitter frequency when it is keyed in short bursts -- unfortunately our test generator does not presently provide the capability to do this; it would be useful to add the circuitry and a switch to select RTS ON continuously, or keyed in short bursts of, say, 200 msec. twice per second. For our tests, we programmed the computer to key the transmitter ON in a continuous series of short pulses. Using an oscilloscope, the bursts can be observed at TP-1, and the transmitter crystal can be trimmed to get it on frequency.

Problem Areas

Generally speaking, the performance of the system meets our expectations and we have had good success demonstrating a terminal configuration at various temporary locations under less than ideal conditions (eg. - makeshift antenna indoors, etc.). However, there are several areas which have caused difficulties, and will require further work.

When the transmitter is aligned according to the manufacturer's instructions (basically a matter of tuning for maximum output), it appears to work normally (generates rated output power, etc.). However, in several instances, I found it difficult to get a stable reading on the frequency counter. Fortunately, we were able to gain access to a spectrum analyzer and have a good look at the output signal. In a word, it was a mess! There were numerous spurious emissions, the strongest of which were 9 and 18 MHz up and down from the desired frequency. In the worst case, one of the spurious signals was actually slightly stronger than the desired signal! (No wonder the frequency counter couldn't decide what frequency it was seeing!) It was a relatively simple matter to realign the transmitter while watching the signal on the spectrum analyzer -- in fact we could get the spurs down by 40 or 50 db without any trouble. (After realignment, true power output was only about 400mw.) The catch, of course, is that few hams have access to a good spectrum analyzer. Unfortunately, I still haven't found any other satisfactory method to align the transmitter for a clean output.

Several difficulties were encountered with the receivers. First of all, something seems to be wrong with the crystal specs for the front-end -- in nearly every case it was barely possible or not possible to bring the front-end exactly on frequency with the trimmer capacitor. In every case, the crystal frequency was a bit low. The same situation was observed with crystals from different suppliers. In one instance, the best frequency was obtained by disconnecting the trimmer -- of course that eliminated any opportunity for fine adjustment.

The actual bandwidth of the transmitted signal, as observed on the spectrum analyzer, with modulation of +/- 2.5 KHz at 9600 bps, is roughly 12 to 14 KHz wide at 6 db down, and not over 22 KHz wide at 30 db down (within the 25 KHz allowable). In order to avoid distortion of the output waveform, the receiver IF must pass at least the first order FM sidebands. With the modifications described earlier, the IF bandwidth was just adequate (although in one case we found a 10.7 MHz crystal filter that was narrower than usual which caused a problem). The typical bandwidth we obtained allows very little leeway for signals that might be a few KHz off-frequency. Ideally, the 455 KHz IF should have a fixed ceramic filter about about 25 KHz wide. This would eliminate fussy receiver alignment and provide enough room for typical frequency errors and drift. Unfortunately, 455 KHz filters at that width are not readily available -- ones designed for narrow-band communications receivers are much narrower, and ones designed for FM stereo broadcast receivers are much wider. (Does anyone know if and where such a filter can be obtained?)

Further Work

Although we are satisfied with the concept, design and the overall performance of our system, the actual hardware used so far, while workable, does present certain difficulties as discussed above. Furthermore, at this time, it appears that VHF Engineering modules will no longer be available in kit form -- the assembled ones may be a bit expensive. For these reasons, we will be continuing to look around for suitable alternatives. I have received initial reports from Randy Smith, VE1SAT, of good results using essentially the same modulator, demodulator and T/R switching circuits with a Hamtronics receiver and transmitter.

One possibility being considered is the design of two new PC boards, one to make a complete transmitter unit, from RS-232 input to RF output (including T/R switch), and one to make a complete receiver unit, from RF input to RS-232 output. If something like that could be made available as a kit, I expect many people would be interested. What about individual boards or kits?? Why not drop me a line, and let me know if you are interested in any or all of the above, or have any other ideas on the subject?

73's

Stan Kazmiruk, VE3JBA

Digipeater Operational in Ottawa

On Monday, April 7, 1980 the first Ottawa packet radio repeater (VE3RMR) became operational. The next day its use was demonstrated to a local amateur radio club; this provided the first two-way communication.

The next four weeks saw four more demonstrations, to the Ottawa Computer Group and three more amateur clubs. Much interest was expressed, but many sceptical questions were raised concerning the use of this technology.

One of the key principles in the effort to get VE3RMR operational has been that it is purely a means, not an end in itself. All of us involved in the project are interested in applying this digital capability to communication needs and opportunities. As an example, work has been progressing on an HF link between Ottawa, Saskatoon, Vancouver and Greenwood N.S. Path testing has begun, and live data testing should begin during August. This HF link uses VE3RMR as a distributor/concentrator, and has a unique protocol or access arrangement.

This highlights one of the foundation-stone features of VE3RMR: it is a highway, or pipeline, over which many different kinds of data can be sent. It is now clear that a number of different protocols will be established (for HF link access, for file transfers, for graphics, etc.), all operating under the pipeline protocol used to access VE3RMR.

This approach, of separating the connection protocol from the content protocols has the great advantage that connecting into the network is kept very simple, and will rarely change. Also, each user may select from a menu of protocols to perform specific tasks in which he is interested. Each user thus tailors a system to his interests, rather than having to use a system containing unused (and unwanted) facilities.

In accordance with the desire to keep things simple, and as first approached by the Vancouver group, a local company has produced a single-board computer that can be used as a peripheral device. This peripheral controls the network transmitter/receiver, and exchanges packets at the other end to/from a terminal or larger computer. A minimum computer (1K RAM, 1K EPROM, 2 serial I/O ports) with network access software costs $275, assembled and tested; by buying the bare board ($70) and populating it yourself, you could be in business for less than $200. The RF gear can still cost about $250, although there is some hope that this cost could be reduced at some point in the future, if a transceiver were designed specifically for high-speed (9600bps or greater) digital work. As you can see below, Stan (VE3JBA) had to make extensive changes to the IF/discriminator section, and add a custom demodulator, in order to achieve the design rate of 9600bps.

The total result is that for about $500 and a keyboard device (Teletype, CRT, computer with RS232 link, etc.) you can be on the network. This is a considerable investment, though not even the cost of a cheap HF transceiver.

For more information on the single-board computer (Z80, 2.5Mhz, max 8K RAM, max 8K EPROM, 2 serial I/O ports, large kluge area), contact: Warren Instrotech Ltd., PO Box 5739, Station "F", Ottawa Ontario K2C 3M1 (telephone 613-728-9120).

HELP WANTED: EXPERIENCED VHF RF CIRCUIT DESIGNERS!!!!! CONTACT STAN KAZMIRUK, 2448 ORIENT PARK DR., OTTAWA K1B 4N1

CANADIAN AMATEUR RADIO FEDERATION INC.
FEDERATION DES RADIO AMATEURS DU CANADA INC.

P.O. BOX 356
KINGSTON, ONT.
K7L 4W2

25 Feb 1980

Dear Packet Radio Enthusiast:

As you can see from the bundle of paper attached to this letter, there is already a lot of information available about Packet Radio for Canadian Amateurs. There is a great deal more to come since each of the three major groups represented in this mailing has more and there are, quite possibly, other groups being formed.

In order to defray the costs of producing this large volume of material, some financial support is required.

To receive further mailings please forward $5.00 to the CARF Office at the above address and mark your envelope "Packet Radio Mailing". This will cover the costs of mailing you the next four Packet Radio Newsletters that will be published over the next twelve months.

Please contact -

Hugh Pett, VE3 FLL
36 Lismer Cres
KANATA, Ont K2K 1A2

concerning items to be included in the Newsletters.

Please contact Art Blick, VE3 AHU, General Manager CARF, at above address for CARF concerning address changes, adding new names to mailings, etc. (extra $5.00 please!).

Also contact the individual groups concerning their activities, for up-to-date circuit diagrams, technical descriptions, etc.

May your packets always CRC!

73 de

A.E. Blick, VE3 AHU
General Manager.

EDITORIAL

One of the more interesting aspects of the editorial task is reading and answering the mail that comes in, in this case mostly to C.A.R.F. about packet radio since the first newsletter was put together. Please check the list of those who have enquired- there may be someone from your part of the world!

The letters tend to be general "How can we get on net?" or "What's the score on packets on 2m where F2 is allowed...". Specific questions are either answered, or referred to someone else. All enquirers get a free copy of the first newsletter, which asks them to "sign up" for future issues.

There is growing interest in packet radio in the U.S., as you can tell from the number of US names in the list. So much so, that QST will likely have at least one article on it in the next year.

Alberta enthusiasts will note a number of additions. A letter from The Aurora Computer Society's committee on Inter-Computer Communications is appended further on.

Activity seems to be picking up somewhat. It appears that a number of "clones" of the 3 systems currently operational will be appearing in the next few months, in places such as Edmonton, Saskatoon and Greenwood N.S.

Observation

My observations at this point in time would be that there are now operational local networks, using a variety of methods, to achieve relatively little. This is perfectly acceptable for now, and marks a significant milestone in the development of amateur packet radio in Canada.

The danger in this situation is that the pioneers will continue using their new tools, and that few others will be attracted to them. This will be avoided by one of two things- very cheap additions for existing equipment (especially 2 meter FM), costing less than $200 COMPLETE (including keyboard, computer, control program, etc., and neatly packaged), or equipment that opens up significant new possibilities for personal communication. This latter approach may be expensive (say, $600), but history has shown that many thousands of people will spend the money, if they expect to gain enough from the investment.

The systems currently in place do not, in my opinion, offer a sufficiently large gain in communication capability to persuade potential users to make such a large investment. What is needed are extra facilities on the networks, to enhance the inter-communication possibilities. A few examples of these facilities could be: tie-ins to Community Bulletin Boards; links to other networks; message store-and-forward; "computer conferencing"; links to specialized data banks; mechanisms for forming common-interest groups to play games, run simulations, alert each other to DX openings, etc.

The era of the pioneer in packet radio is rapidly drawing to a close, having lasted only two years. A few more pioneers will crop up, but from now on most people will want to replicate existing systems- the "early adopters". This phase too will be short, a couple of years perhaps. Overlapping it, hopefully, will be the era of "sound managers" who will grasp the tool and shape it to many ends. This last group will include some pioneers, and some early adopters; it is the most important group, if packet radio is to achieve its full potential in the years ahead.

The search is on now for applications that can exploit packet radio's characteristics of rapid, continuous access, shared simultaneously by many users.

THE NEXT NEWSLETTER WILL REPORT ON APPLICATIONS. LET'S HEAR YOUR IDEAS!!

December 14th, 1979

Mr. Bob Rouleau
1050 Churchill
Mt. Royal Quebec H3R 3B6

Dear Bob,

I want to thank you again for taking the time to bring me up-to-date on the activities of your group and your future plans.

The local repeater committee (of WR6AIS) was very favorably impressed by the possibilities of a packet repeater project, and my feeling is now that it's really going to happen here within the next 6 months.

Some of our rf wizzards insisted that L-band was the place to start, and they convinced me that the equipment required was not too difficult to construct.

The MEK6800d2 which I have on hand appears to meet the minimum requirements to utilize your protocol 'as is'. Thus the call to you requesting the program listing, which I hope you will send me at your earliest convenience.

The packet repeater will be housed at the same site as our 2-meter machine, and at least two people from SRI are already on the project. I hope we may be able to draw on their colleagues who did some of the government studies in this area.

I look forward to keeping in touch with you on developments in this area.

With best regards to you for the holidays,

H. S. Magnuski

COPY

December 14th, 1979

Mr. Bob Rouleau
1050 Churchill
Mt. Royal Quebec H3R 3P6

Dear Bob,

I want to thank you again for taking the time to bring me up-to-date on the activities of your group and your future plans.

The local repeater committee (of VE2AIS) was very favorably impressed by the possibilities of a packet repeater project, and my feeling is now that it's really going to happen here within the next 6 months.

Some of our ff wizards insisted that 1-band was the place to start, and they convinced me that the equipment required was not too difficult to construct.

The MEK6800d2 which I have on hand appears to meet the minimum requirements to utilize your protocol 'as is'. Thus the call to you requesting the program listing, which I hope you will send me at your earliest convenience.

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